

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Vecchio, Kenneth)
)
Divisional of) Predecessor Application
Serial No.: 09/130,722) Group Art Unit: 3641
)
Predecessor Application) Predecessor Application
Filed: August 6, 1998) Examiner: Johnson, S.
)
For: PROCESS FOR MAKING METALLIC/INTERMETALLIC COMPOSITE LAMINATE
MATERIALS, AND MATERIALS SO PRODUCED ESPECIALLY FOR USE IN
LIGHTWEIGHT ARMOR)
)
Atty's Docket No.: UCA 98-065DIV)
)
San Diego, California
February 11, 2002

PRELIMINARY AMENDMENT UNDER 37 C.F.R. §115
TO THE DIVISIONAL PATENT APPLICATION

Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231
Dear Sir:

Please preliminarily amend the present divisional patent
application as follows:

In The Specification

Please add on the first page as a new section intermediary
in location between (i) the first paragraph and (ii) the section
"BACKGROUND OF THE INVENTION":

-- REFERENCE TO A RELATED PATENT APPLICATION
The present application is a divisional of U.S. patent
application 09/130,722 of the same name filed August 6,
1998, to the same inventor, which application issued AAAA
BB, 2002 as U.S. Patent No. CC/D,DDD,DDD.--

A copy of the amended page in plain text form is attached.

In The Claims

Please amend claims 16-19, 21-29, and 41-43. Please cancel

CLAIMS (IN PLAIN TEXT FORM)

What is claimed is:

1. (Amended) A method of making a composite laminate material comprising:

interleaving

a plurality of first foils made from one or more first metals and metal alloys, with

a plurality of second foils made from one or more second metals and metal alloys suitable to react with the one or more first metal and metal alloys to produce a hard intermetallic compound; and

reacting in situ under heat and pressure in the presence of atmospheric gases the plurality of first foils with the plurality of second foils so as to substantially completely react the one or more second metals and metal alloys with the one or more first metal and metal alloys, forming where each second metal foil had been a region of hard intermetallic compound;

wherein a composite laminate material having (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of an hard intermetallic compound, is made.

2. (Restated) A method of making a composite laminate material comprising:

interleaving

a plurality of first foils made from one or more first metals or metal alloys from the group consisting of titanium, nickel, vanadium, iron and alloys and combinations of titanium, nickel, vanadium and iron, with

a plurality of second foils made from one or more second metals and metal alloys from the group consisting of aluminum and alloys of aluminum; and

reacting under heat and pressure in the presence of atmospheric gases the plurality of first foils with the plurality of second foils so as to substantially completely react the one or more second metals and metal alloys with the one or more first

metal and metal alloys, forming where each second metal foil had been a region of hard intermetallic compound;

wherein a composite laminate material having (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of a hard intermetallic compound, is made.

3. (Restated) The method of making a composite laminate material according to claim 1 or claim 2 wherein the reacting under heat and pressure comprises:

placing the interleaved pluralities of first foils and second foils under pressure:

raising the temperature of the pressured interleaved foils to (i) less than a melting point of the one or more second metals and metal alloys but (ii) sufficiently high so that, at pressure, solid state diffusion occurs between the interleaved foils, physically locking the foils in place;

further raising the temperature of the pressured, diffused, locked interleaved foils until all the one or more second metals are reacted with the one or more first metals to form an intermetallic compound, this raising being done sufficiently slowly and under sufficient continuing pressure so that, despite the facts that the reacting proceeds with increasing difficulty and an ultimate high temperature reached is greater than a melting point of the one or more second metals, the one or more second metals remain initially locked in place and ultimately become reacted without squirting in liquid state from between the first foils; and

cooling the composite laminate material as is made from (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of an hard intermetallic compound, to room temperature;

wherein each of the placing, raising, further raising, and cooling transpires in the presence of atmospheric gases;

wherein the second foils become completely reacted with the first foils nonetheless that the temperature of liquefaction of the at least one second metals and metal alloys from which the second foils are made is exceeded in the process.

4. (Restated) The method according to claim 1 or claim 2 wherein the interleaving is of a pluralities of first and second foils more numerous than ten.

5. (Restated) The method according to claim 1 or claim 2 wherein the interspersing is of pluralities of first and second foils having thicknesses in the range of .1 mm to 1 mm.

6. (Restated) The method according to claim 1 or claim 2 wherein the interspersing is of pluralities of first and second foils having thicknesses less than .2 mm.

7. (Restated) The method according to claim 1 or claim 2 wherein the maximum temperature of the reacting is in the range from 600-800°C.

8. (Restated) The method according to claim 1 or claim 2 wherein the reacting under heat and pressure comprises:
pressuring in a mechanical press.

9. (Restated) The method according to claim 1 or claim 2 wherein the reacting under heat and pressure comprises:
pressuring in a load frame.

10. (Restated) The method according to claim 1 or claim 2 wherein the reacting under heat and pressure is under a maximum pressure in the range from 1-10 megapascals.

11. (Restated) The method according to claim 1 wherein the interspersing is of a plurality of first foils made of one or more metals and metal alloys from the group consisting of titanium, nickel, vanadium, iron and alloys and combinations of titanium, nickel, vanadium and iron.

12. (Restated) The method according to claim 1 wherein the interspersing is of a plurality of second foils

made of one or more metals and metal alloys from the group consisting of aluminum and alloys of aluminum.

13. (Restated) The method according to claim 1 or claim 2 wherein the interspersing is of a plurality of first foils made from one or more first metals and metal alloys having a plane strain fracture toughness, in the state of the first metals and metal alloys that is assumed upon completion of the method, of greater than 40 MPa√m, with a plurality of second metal foils made from one or more second metals and metal alloys suitable to compound with the first metal and metal alloys to produce an intermetallic compound having a Vickers microhardness of greater than 400 kg/mm².

14. (Restated) The composite laminate material produced by the method of claim 1 or claim 2, characterized for having (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of an intermetallic compound consisting of the one or more first metals and metal alloys reacted with the one or more second metals and metal alloys.

16. (Amended) The method according to claim 1 or claim 2 wherein the laminating is of one or more tough first metals and metal alloys drawn from the group consisting of titanium, nickel, vanadium and iron, and combinations of titanium, nickel, vanadium, and iron.

17. (Amended) The method according to claim 1 or claim 2 wherein the laminating is of one or more second metals or metal alloys drawn from the group consisting of aluminum and alloys of aluminum.

18. (Amended) The method according to claim 1 or claim 2 producing the composite laminate material in a non-planar contour so as to improve its penetration resistance.

19. (Amended) The method according to claim 1 or claim 2 producing the composite laminate material in corrugated form so as to improve its penetration resistance.

21. (Amended) The method according to claim 1 or claim 2 producing composite laminate material having a density between 3 and 4.5 grams per cubic centimeter.

22. (Amended) The method according to claim 1 or claim 2 producing composite laminate material having a density less than 6 grams per cubic centimeter.

23. (Amended) The method according to claim 1 or claim 2 wherein the interleaving is of a plurality of first foils and a plurality of second foils under stress;

wherein the produced composite laminate material has residual internal stresses between its metal layers and its intermetallic regions.

24. (Amended) The composite laminate material produced by the method according to claim 1 or claim 2 adapted for use as armor.

25. (Amended) The method according to claim 1 or claim 2 wherein the interleaving is of metal layers that are in a three-dimensional, non-planar, contour;

wherein the intermetallic regions are in a three-dimensional, non-planar, contour congruent with the contour of the metal layers;

whereby the produced composite laminate material is in a three-dimensional, non-planar, contour.

26. (Amended) The method according to claim 1 or claim 2 wherein the interleaving is of metal layers that are in a corrugated contour; and

wherein the intermetallic regions are in a corrugated contour congruent with the contour of the metal layers;

whereby the produced composite laminate material is in a

corrugated contour.

27. (Amended) The method according to claim 1 or claim 2
wherein the interleaving is of metal layers that are both
greater than 10 in number and larger than 100 cm² in area.

5 28. (Amended) The method according to claim 1 or claim 2
wherein the composite laminate material produced is
characterized in that its metal layers have a toughness, in the
state of the metals and metal alloys that is assumed upon
completion of the method, of greater than 40 MPa√m.

10 29. (Amended) The method according to claim 1 or claim 2
wherein the composite laminate material produced is
characterized in that its regions of intermetallic material have a
Vickers microhardness of greater than 400 kg/mm².

15 41. (Amended) The method according to claim 1 or claim 2
wherein the interleaving is of metal layers that are of
differing thickness.

42. (Amended) The method according to claim 1 or claim 2
wherein the interleaving is of intermetallic regions that are
of differing thickness.

20 43. (Amended) The method according to claim 1 or claim 2
wherein the interleaving is of a plurality of first foils and
a plurality of second foils under stress;
wherein the produced composite laminate material has such
residual internal stresses between the metal layers and
25 intermetallic regions as do serve to more substantially deflect a
penetrating projectile from off its axis of impact than would be
the case for the same penetrating projectile without the residual
internal stresses.

44. (Added) Laminate armor CHARACTERIZED IN THAT it is

corrugated.

45. (Added) The corrugated laminate armor according to claim 44 FURTHER CHARACTERIZED IN THAT the armor is made from

a plurality of metal layers of one or more tough first metals or metal alloys; interleaved with

a plurality of regions, coextensive with the metal layers, of hard intermetallic material consisting of (i) the one or more first metals or metal alloys reacted with (ii) one or more second metals or second metal alloys;

wherein the tough metal layers are separated by the hard intermetallic regions, and vice versa; and

wherein reaction of the second metals or metal alloys with the first metals metal alloys forms the hard intermetallic material in situ within the laminate armor.

46. (Added) The corrugated laminate armor according to claim 45 FURTHER CHARACTERIZED IN THAT

the plurality of metal layers are selected from the group consisting of titanium, nickel, vanadium, and iron and alloys and combinations of titanium, nickel, vanadium, and iron;

the plurality of intermetallic regions are selected from the group consisting of (i) said titanium, nickel, vanadium, and iron and alloys and combinations of titanium, nickel, vanadium, and iron reacted with (ii) aluminum or alloys of aluminum.

47. (Added) The corrugated laminate armor according to claim 44 FURTHER CHARACTERIZED IN THAT

major surfaces of the corrugations undergo undulations of greater extent from peak to valley than is a thickness of the laminate.

48. (Added) Armor comprising:

a metal laminate corrugated upon its major surfaces, meaning that it undergoes undulations of greater extent from peak to valley than is a thickness of the laminate;

the metal laminate consisting essentially of

a plurality of metal layers of one or more tough first metals or metal alloys, interleaved with

a plurality of regions, coextensive with the metal layers, of hard intermetallic material consisting of (i) the one or more first metals or metal alloys reacted with (ii) one or more second metals or second metal alloys,

wherein the tough metal layers are separated by the hard intermetallic regions, and vice versa, and

wherein reaction of the second metals or metal alloys with the first metals metal alloys forms the hard intermetallic material in situ within the laminate armor.

49. (Added) The armor according to claim 48

wherein within the metal laminate the plurality of metal layers are selected from the group consisting of titanium, nickel, vanadium, and iron and alloys and combinations of titanium, nickel, vanadium, and iron; and

the plurality of intermetallic regions are selected from the group consisting of (i) said titanium, nickel, vanadium, and iron and alloys and combinations of titanium, nickel, vanadium, and iron reacted with (ii) aluminum or alloys of aluminum.

REMARKS

Applicant does **not** invite a further requirement for

restriction, and, **indeed**, finds that since his claimed "corrugations" should properly be examined in certain dependent claims dependent upon independent claims 1,2, then this aspect of the invention **can** and **should** be concurrently examined for claims 44-49, and that a further requirement for restriction in the present divisional application is improper.

2. Summary

The present amendment is compatible with both (i) Applicant's elections, and claim cancellations, in response to the requirement for restriction in the previous application, **and**, (ii) Applicant's previous exercise of the option presented in block 5 of the Advisory Action mailed June 5, 2001. No new subject matter has been introduced by the present amendment.

In consideration of the preceding amendment and accompanying remarks, the present divisional application is deemed in condition for substantive examination. The timely action of the Examiner to that end is earnestly solicited.

10074057-03403

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Serial No.: 09/130,722
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Applicant's undersigned attorney is at the Examiner's disposal should the Examiner wish to discuss any matter which might expedite prosecution of this case.

Sincerely yours,

William C. Fuess

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☐ Filed Under 37 CFR §1.34(a)

CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that these documents and the associated divisional patent application are being deposited with the United States Postal Service in an envelope as "Express Mail Post Office to Addressee" mailing Label Number ET655458786US addressed to the: Commissioner of Patents and Trademarks, Washington, D.C. 20231, ATTN: Box Patent Application on the date written below.

February 11, 2002
Date

William C. Fuess
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CLAIMS (IN AMENDED FORM)

What is claimed is:

1. (Amended) A method of making a composite laminate material comprising:

interleaving

a plurality of first foils made from one or more first metals and metal alloys, with

a plurality of second foils made from one or more second metals and metal alloys suitable to [compound] react with the one or more first metal and metal alloys to produce a hard intermetallic compound; and

reacting in situ under heat and pressure in the presence of atmospheric gases the plurality of first foils with the plurality of second foils so as to substantially completely react the one or more second metals and metal alloys with the one or more first metal and metal alloys, forming where each second metal foil had been a region of hard intermetallic compound;

wherein a composite laminate material having (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of an hard intermetallic compound, is made.

2. (Restated) A method of making a composite laminate material comprising:

interleaving

a plurality of first foils made from one or more first metals or metal alloys from the group consisting of titanium, nickel, vanadium, iron and alloys and combinations of titanium, nickel, vanadium and iron, with

a plurality of second foils made from one or more second metals and metal alloys from the group consisting of aluminum and alloys of aluminum; and

reacting under heat and pressure in the presence of atmospheric gases the plurality of first foils with the plurality of second foils so as to substantially completely react the one or more second metals and metal alloys with the one or more first

metal and metal alloys, forming where each second metal foil had been a region of hard intermetallic compound;

wherein a composite laminate material having (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of a hard intermetallic compound, is made.

3. (Restated) The method of making a composite laminate material according to claim 1 or claim 2 wherein the reacting under heat and pressure comprises:

placing the interleaved pluralities of first foils and second foils under pressure:

raising the temperature of the pressured interleaved foils to (i) less than a melting point of the one or more second metals and metal alloys but (ii) sufficiently high so that, at pressure, solid state diffusion occurs between the interleaved foils, physically locking the foils in place;

further raising the temperature of the pressured, diffused, locked interleaved foils until all the one or more second metals are reacted with the one or more first metals to form an intermetallic compound, this raising being done sufficiently slowly and under sufficient continuing pressure so that, despite the facts that the reacting proceeds with increasing difficulty and an ultimate high temperature reached is greater than a melting point of the one or more second metals, the one or more second metals remain initially locked in place and ultimately become reacted without squirting in liquid state from between the first foils; and

cooling the composite laminate material as is made from (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of an hard intermetallic compound, to room temperature;

wherein each of the placing, raising, further raising, and cooling transpires in the presence of atmospheric gases;

wherein the second foils become completely reacted with the first foils nonetheless that the temperature of liquefaction of the at least one second metals and metal alloys from which the second foils are made is exceeded in the process.

4. (Restated) The method according to claim 1 or claim 2
wherein the interleaving is of a pluralities of first and
second foils more numerous than ten.
5. (Restated) The method according to claim 1 or claim 2
5 wherein the interspersing is of pluralities of first and
second foils having thicknesses in the range of .1 mm to 1 mm.
6. (Restated) The method according to claim 1 or claim 2
wherein the interspersing is of pluralities of first and
second foils having thicknesses less than .2 mm.
- 10 7. (Restated) The method according to claim 1 or claim 2
wherein the maximum temperature of the reacting is in the
range from 600-800°C.
- 15 8. (Restated) The method according to claim 1 or claim 2 wherein
the reacting under heat and pressure comprises:
pressuring in a mechanical press.
9. (Restated) The method according to claim 1 or claim 2 wherein
the reacting under heat and pressure comprises:
pressuring in a load frame.
- 20 10. (Restated) The method according to claim 1 or claim 2
wherein the reacting under heat and pressure is under a
maximum pressure in the range from 1-10 megapascals.
- 25 11. (Restated) The method according to claim 1
wherein the interspersing is of a plurality of first foils
made of one or more metals and metal alloys from the group
consisting of titanium, nickel, vanadium, iron and alloys and
combinations of titanium, nickel, vanadium and iron.
12. (Restated) The method according to claim 1
wherein the interspersing is of a plurality of second foils

made of one or more metals and metal alloys from the group consisting of aluminum and alloys of aluminum.

13. (Restated) The method according to claim 1 or claim 2 wherein the interspersing is of a plurality of first foils made from one or more first metals and metal alloys having a plane strain fracture toughness, in the state of the first metals and metal alloys that is assumed upon completion of the method, of greater than $40 \text{ MPa}\sqrt{\text{m}}$, with a plurality of second metal foils made from one or more second metals and metal alloys suitable to compound with the first metal and metal alloys to produce an intermetallic compound having a Vickers microhardness of greater than 400 kg/mm^2 .

14. (Restated) The composite laminate material produced by the method of claim 1 or claim 2, characterized for having (i) layers of one or more first metals and metal alloys, interspersed with (ii) regions of an intermetallic compound consisting of the one or more first metals and metal alloys reacted with the one or more second metals and metal alloys.

16. (Amended) The [composite laminate material] method according to claim [15] 1 or claim 2

wherein the laminating is of one or more tough first metals and metal alloys [are] drawn from the group consisting of titanium, nickel, vanadium and iron, and combinations of titanium, nickel, vanadium, and iron.

17. (Amended) The [material] method according to claim 1[5] or claim 2

wherein the laminating is of one or more second metals or metal alloys [are] drawn from the group consisting of aluminum and alloys of aluminum.

18. (Amended) The [material] method according to claim [15] 1 or claim 2 producing the composite laminate material in a non-planar

contour so as to improve its penetration resistance.

19. (Amended) The [material] method according to claim [18] 1 or claim 2 producing the composite laminate material in corrugated form so as to improve its penetration resistance.

5 21. (Amended) The [composite laminate material] method according to claim 1[5] or claim 2[0] producing composite laminate material having a density between 3 and 4.5 grams per cubic centimeter.

10 22. (Amended) The [composite laminate material] method according to claim 1[5] or claim 2[0] producing composite laminate material having a density less than 6 grams per cubic centimeter.

23. (Amended) The [composite laminate material] method according to claim 1[5] or claim 2[0]

wherein the interleaving is of a plurality of first foils and a plurality of second foils under stress;

15 wherein the produced composite laminate material ha[ving]s residual internal stresses between [the] its metal layers and [the] its intermetallic regions.

20 24. (Amended) The composite laminate material produced by the method according to claim 1[5] or claim 2[0] adapted for use as armor.

25 25. (Amended) The [composite laminate material] method according to claim 1[5] or claim 2[0]

wherein the interleaving is of metal layers that are in a three-dimensional, non-planar, contour;

wherein the intermetallic regions are in a three-dimensional, non-planar, contour congruent with the contour of the metal layers;

whereby the produced composite laminate material is in a three-dimensional, non-planar, contour.

26. (Amended) The [composite laminate material] method according

to claim 1[5] or claim 2[0]

wherein the interleaving is of metal layers that are in a corrugated contour; and

wherein the intermetallic regions are in a corrugated contour congruent with the contour of the metal layers;

whereby the produced composite laminate material is in a corrugated contour.

27. (Amended) The [composite laminate material] method according to claim 1[5] or claim 2[0]

wherein the interleaving is of metal layers that are both greater than 10 in number and larger than 100 cm² in area.

28. (Amended) The [composite laminate material] method according to claim 1[5] or claim 2[0]

wherein the composite laminate material produced is characterized in that its metal layers have a toughness, in the state of the metals and metal alloys that is assumed upon completion of the method, of greater than 40 MPa√m.

29. (Amended) The [composite laminate material] method according to claim 1[5] or claim 2[0]

wherein the composite laminate material produced is characterized in that its regions of intermetallic material have a Vickers microhardness of greater than 400 kg/mm².

41. (Amended) [Armor] The method according to claim [30] 1 or claim [33] 2

wherein the interleaving is of metal layers that are of differing thickness.

42. (Amended) [Armor] The method according to claim [30] 1 or claim [33] 2

wherein the interleaving is of intermetallic regions that are of differing thickness.

43. (Amended) [Armor] The method according to claim [30] 1 or claim [33] 2

wherein the interleaving is of a plurality of first foils and a plurality of second foils under stress;

5 wherein the produced composite laminate material ha[ving]s
such residual internal stresses between the metal layers and intermetallic regions as do serve to more substantially deflect a penetrating projectile from off its axis of impact than would be the case for the same penetrating projectile without the residual
10 internal stresses.

44. (Added) Laminate armor CHARACTERIZED IN THAT it is corrugated.

45. (Added) The corrugated laminate armor according to claim 44 FURTHER CHARACTERIZED IN THAT the armor is made from

15 a plurality of metal layers of one or more tough first metals or metal alloys; interleaved with

a plurality of regions, coextensive with the metal layers, of hard intermetallic material consisting of (i) the one or more first metals or metal alloys reacted with (ii) one or more second metals or second metal alloys;

20 wherein the tough metal layers are separated by the hard intermetallic regions, and vice versa; and

wherein reaction of the second metals or metal alloys with the first metals metal alloys forms the hard intermetallic material in
25 situ within the laminate armor.

46. (Added) The corrugated laminate armor according to claim 45 FURTHER CHARACTERIZED IN THAT

the plurality of metal layers are selected from the group consisting of titanium, nickel, vanadium, and iron and alloys and combinations of titanium, nickel, vanadium, and iron;

30 the plurality of intermetallic regions are selected from the group consisting of (i) said titanium, nickel, vanadium, and iron and alloys and combinations of titanium, nickel, vanadium, and iron

reacted with (ii) aluminum or alloys of aluminum.

47. (Added) The corrugated laminate armor according to claim 44
FURTHER CHARACTERIZED IN THAT

major surfaces of the corrugations undergo undulations of
greater extent from peak to valley than is a thickness of the
laminate.

48. (Added) Armor comprising:

a metal laminate corrugated upon its major surfaces, meaning
that it undergoes undulations of greater extent from peak to valley
than is a thickness of the laminate;

the metal laminate consisting essentially of

a plurality of metal layers of one or more tough first
metals or metal alloys, interleaved with

a plurality of regions, coextensive with the metal
layers, of hard intermetallic material consisting of (i) the one or
more first metals or metal alloys reacted with (ii) one or more
second metals or second metal alloys,

wherein the tough metal layers are separated by the hard
intermetallic regions, and vice versa, and

wherein reaction of the second metals or metal alloys
with the first metals metal alloys forms the hard intermetallic
material in situ within the laminate armor.

49. (Added) The armor according to claim 48

wherein within the metal laminate the plurality of metal
layers are selected from the group consisting of titanium, nickel,
vanadium, and iron and alloys and combinations of titanium, nickel,
vanadium, and iron; and

the plurality of intermetallic regions are selected from the
group consisting of (i) said titanium, nickel, vanadium, and iron
and alloys and combinations of titanium, nickel, vanadium, and iron
reacted with (ii) aluminum or alloys of aluminum.